APPENDIX 7-48

SUPPLEMENTAL INFORMATION, HYDROLOGIC CONDITIONS

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HYDROLOGIC CONDITIONS LBA #9 AREA - Supplemental Information

1.0 INTRODUCTION

This report provides supplemental information to the LBA #9 package previously submitted by Genwal Coal Company Inc. to the Price office of the Manti-LaSal National Forest. This report also assesses potential mining impacts. Much of the information contained herein was requested by USFS and DOGM personnel (during telephone consultations and field reconnaissance) to aid in their evaluation of the LBA #9 submittal package.

Information presented and discussed herein include the following:

- Stream flow in the north and south forks of Horse Canyon, Blind Canyon, north and south forks of Crandall Canyon, Indian Creek, and two drainages on the west-facing slope of East Mountain in the western half of T15S-R6E-Sec 35,

- Tritium and geochemical data collected from springs in Joes Valley and on the west-facing slope of East Mountain,

- Natural mass movement occurrence on the west-facing slope of East Mountain, and

- Assessment of possible effects of mine-induced subsidence on the hydrologic system.

Much of this information relates to USFS concerns regarding potential impacts of retreat mining on East Mountain, and what affects these impacts may have on the Joes Valley hydrologic system. This report presents evidence suggesting the likelihood of detrimental impacts occurring to the Joes Valley area are very minimal. Nonetheless, Genwal Coal Company has committed to installing a Parshall Flume in the Upper Indian Creek to monitor potential effects to Indian Creek that, although very unlikely, may result from mining.

2.0 STREAM FLOW

Parshall flumes equipped with Stevens Type-F continuous water level recorders have been installed and maintained in Crandall (two flumes) and Blind (one flume) Canyons. The Crandall Canyon flume measurements have been recorded from May, 1988 to the present time. Stream discharge measurements from the Blind Canyon flume have been recorded from July, 1991 to present. Stream discharges measured at the flume sites are found in the previously submitted LBA #9 submittal package.

In addition to the flume measurements, stream flow discharges have been measured at established stream monitoring stations along Horse Creek, Blind Canyon, and the north and south forks of Crandall Canyon from April through November 1991. These stream monitoring stations extend to the uppermost extent of the stream drainages. Stream flow measurements collected at these stations also appear in the previously submitted LBA #9 package.

Permits to install a Parshall Flume and a Stevens Type-F water level recorder in Indian Creek (T16S-R6E-Sec10 SE1/4 SW 1/4) have been filed with the United States Forest Service and the Utah Division of Water Rights. Installation is anticipated to occur during the fall of 1992.

Stream flow conditions in the north and south forks of Horse and Crandall Canyons, Blind Canyon, Indian Creek, and two drainages on the west-facing slope of East Mountain in T15S-R6E-Sec 35 W1/2, have been observed and recorded during seep and spring surveys. Consultations with Manti-LaSal National Forest personnel have revealed that the extent of flow measured in October during two consecutive years is used to define the extent of perennial stream reaches. Consequently, measurements collected that apply with this definition of perennial flow have been used. Observations of stream flow conditions present during October 1989 indicate perennial flow existed below the following elevations:

DRAINAGE	EVEV. TOP OF PERENNIAL FLOW
Blind Canyon	8300 ft. AMSL
North Fork of Crandall Canyon	8400 ft. AMSL
South Fork of Crandall Canyon	8440 ft. AMSL
T15S-R6E-Sec 35 W1/2 Drainages	No Perennial Flow

The two drainages on the west-facing slope of East Mountain in T15S-R6E-Sec 35 W1/2, have been observed to be dry during all fall seep and spring surveys conducted from 1985 through 1990. Flow was observed during the fall 1991 survey; however, flow was not measured due to the presence of field conditions (rain and melting snow) that would mask any natural perennial flow or lack of flow.

The stream flow conditions monitored in 1991 indicate that 1991 perennial flow existed below the following elevations:

DRAINAGE	ELEV. TOP OF PERENNIAL FLOW
Blind Canyon	9640 ft. AMSL
North Fork of Crandall Canyon	9020 ft. AMSL
South Fork of Crandall Canyon	8940 ft. AMSL
North Fork of Horse Canyon	No perennial flow
South Fork of Horse Canyon	9400 ft. AMSL

The 1991 stream flow conditions were monitored at least once a month from the period of April 15th through November 13th. Rainfall occurred immediately prior to or during the late summer and fall monthly stream surveys. These flow measurements are found in the LBA #9 package and were used to design the stream buffer zones in the mine plan.

3.0 TRITIUM AND GEOCHEMICAL ANALYSIS OF JOES VALLEY AND EAST MOUNTAIN SPRINGS

Tritium and geochemical analyses were conducted on water samples collected on June 11, 1992. Analyses were conducted to determine if gross features (tritium age - water residence time in the subsurface, and gross geochemistry) indicate the presence of more than one water source in Joes Valley and the west-facing slope of East Mountain.

Field evidence suggests that at least two water regimes are contributing water to Indian Creek. First, seep and spring flow as well as surface sheet flow (primarily during episodes of rainfall and snowmelt), on the west-facing slope of East Mountain provide waters that infiltrate into the Holocene colluvium at the base of East Mountain. This water is then postulated to surface to the west and southwest (down gradient) at springs, which provide water to Indian Creek. Field observations suggest this scenario is operating in T15S-R6E-Sec 34 SW 1/4, and T16S-R6E-Sec 3 N1/2 NE1/4. Second, the linear occurrence of springs in T16S-R6E-Sec 3 S1/2 NE1/2, and T16S-R6E-Sec 3 SE1/4, suggest water may be surfacing via a subsidiary fault trending N-S parallel to the main Joes Valley Fault. This suspected fault lies on the down-thrown fault block approximately 1/4 mile west of the main Joes Valley Fault. In contrast to up-thrown fault blocks, the down-thrown fault blocks in this region typically contain subsidiary faults. The subsidiary faults trend parallel to the major fault, in this case the Joes Valley Fault at the base of East Mountain. The springs suspected to be emerging from the subsidiary faults contain tufa mounds, which are not present at the springs which appear to be related to the colluvium discussed above.

3.1 Tritium Analysis

Tritium analyses were conducted on samples collected from springs SP1-1a, SP1-47, SP1-42a, and SP1-37. Spring locations are shown on Plate 1. Analyses were conducted by the

Tritium Laboratory, Rosenthal School of Marine and Atmospheric Science, University of Miami.

Laboratory analytical results appear in Appendix 1. Sample EarthFax-1 corresponds to spring SP1-1a. Sample EarthFax-2 was collected from spring SP1-47, EarthFax-3 from spring SP1-37, and EarthFax-4 from spring SP1-42a.

The laboratory results indicate Tritium Unit (TU) concentrations range from 19.2 to 38.2 TU. These tritium unit values indicate the spring waters consist of mixed, new and old water. Old water being water not in communication with the atmosphere since 1952. New water being water in communication with the atmosphere since 1952. It is not possible to determine from these results the degree of mixing, or ages of the waters mixed. As a result, tritium dating neither supports or negates the presence of one, or more than one source of groundwater in the upper Indian Creek.

3.2 Geochemical Analysis

Geochemical analyses were conducted on water samples collected from springs SP1-1a (Genwal-1), SP1-47 (Genwal-2), SP1-37 (Genwal-3), SP1-42a (Genwal-4), SP1-31, SP1-30a, and the drainage in T15S-R6E-Sec 35 N1/2 SW1/4. Laboratory analytical results are found in Appendix 2. Analytical testing was performed by Chemtech Analytical Laboratories of Salt Lake City.

Stiff diagrams constructed from the geochemical analyses reveal that the general character of all the groundwater samples are that of a calcium-magnesium-bicarbonate water. Stiff diagrams appear in Plate 1. The stiff diagrams are plotted on a scale of zero to ten milliequivalents (MEQ). The Stiff diagrams indicate that waters of Joes Valley and the west-facing slope of East Mountain are very similar in their geochemical nature. This is not surprising since waters in both areas are migrating through similar formations. As a result, these results do not indicate the number of hydrologic regimes present in the Joes Valley-East

Mountain Area. Although sulfate is present in different relative quantities, it does not vary to a degree sufficient to identify different hydrologic regimes. Due to the similar nature of the geochemistry of all samples, Piper Plots were not constructed.

4.0 NATURAL MASS MOVEMENT ON THE WEST-FACING SLOPE OF EAST MOUNTAIN

At the request of Manti-LaSal National Forest personnel, Genwal Coal Company has mapped the sites of natural mass movement on the west-facing slope of East Mountain. Mapping was performed by conducting an aerial photographic interpretation of the following area: T15S-R6E-Sec35 SW1/4, T16S-R6E-Sec2 W1/2, T16S-R6E-Sec11 W1/2, and T16S-R6E-Sec10 E1/2 E1/2. Aerial photos taken July 3, 1976, and September 27, 1984 were stereoscopically studied. The 1976 photos predate the heavy snowfall of 1983/1984. The September 27, 1984 survey postdate the heavy snowfall of 1983/1984, and records the natural mass movement features that resulted from the heavy precipitation.

Mass movement features present in 1976 and 1984 are shown on Plate 2. Plate 2 shows that two of the three sites of mass movement present in 1976 were reactivated in 1984.

Field observations indicate a large portion of the tree trunks on the west-facing slope of East Mountain are curved in a manner indicating the occurrence of natural soil creep. Furthermore, the presence of sediment lobes at the base of East Mountain further indicate the presence of historic natural mass movement down the west-facing slope of East Mountain.

5.0 SUBSIDENCE MAGNITUDES AND OVERBURDEN MINERALOGY

5.1 Subsidence Magnitudes

Modeling of mine-induced subsidence that may result from mining the Hiawatha Coal Seam beneath East Mountain has been conducted by TerraTek Geoscience Services of Salt Lake City (TerraTek, 1991). The anticipated magnitude of subsidence of East Mountain was calculated using the following techniques:

- National Coal Board Technique,
- Results of the Deer Creek Subsidence Study, and
- Elastic Analysis.

These analyses indicate the maximum magnitude of surface subsidence to be no more than three to four inches. The draw angle is expected to be approximately 20°.

5.2 Clay Mineralogy of the Hiawatha Coal Seam Overburden

The mineralogy of the Hiawatha Coal Seam overburden has been studied to determine its capacity to seal mine-induced subsidence fractures, and thereby protect the hydrologic system (small laterally discontinuous perched aquifers) present above the Hiawatha Coal. The presence of both clay minerals and the capacity for cementing agents to aid in fracture healing have been investigated. Results of this study are outlined in, "Mineralogy of the Crandall Canyon Mine Overburden, Implications for Healing of Fractures Resulting From Retreat Mining." SEE APPENDIX 2-1.

X-ray diffraction analysis of the Hiawatha overburden reveal the presence of a number of clay minerals. Swelling clays present include mixed-layer smectite-illite, mixed-layer smectite-chlorite, and pure smectite (bentonite). Significant quantities of swelling clays were found in the Blackhawk, Castlegate, and Price River Formations (EarthFax, 1992). Due to their high cation-exchange capacities, these swelling clay minerals are able to occlude void areas and impede migration of groundwater. Smectite is a standard clay used in the completion of groundwater wells due to its water sealing property. Kaolin and illite clay minerals are also present in the Blackhawk, Castlegate, and Price River Formations (EarthFax, 1992). These minerals will also aid in sealing fractures that result from retreat mining.

Core analysis reveal that calcite forms the dominant cement present in the Blackhawk, Castlegate, and Price River Formations overlying the Crandall Canyon Mine. Analyses of groundwater chemistry and chemical conditions controlling precipitation of calcite indicate that precipitation of calcite along the fracture planes produced by retreat mining will occur (EarthFax, 1992). Furthermore, the presence of tufa deposits at selected springs (principally of the Blackhawk Formation) indicate that precipitation of calcite is occurring.

5.3 Self-Healing of Subsidence Fractures

A study conducted by the Fish Lake National Forest in the overburden of Coastal States Energy Corporation's SUFCO #1 Mine in Convulsion Canyon, Utah, indicate that 56 percent of the tension fractures produced by retreat mining are physically self-healing (DeGraff, 1978). Both mines, Genwal's Crandall Canyon and SUFCO's Convulsion Canyon, mine coal of the Hiawatha Coal Seam, and are overlain by similar formations containing similar lithologies. The amount of fracture-healing ranged from 13 to 100 percent (DeGraff, 1978). Physical rates of subsidence fracture closure ranged from less than 1/32 inch to more than 1/4 inch per week (DeGraff, 1978). An average fracture closure rate of greater than 1/16 inch per week was measured (DeGraff, 1978). These data indicate that 56 percent of the maximum width of tension fractures are physically self-healing.

Compressional fractures, which also result from retreat mining, were not analyzed in DeGraff's study. Compressional fractures are held closed tightly by compressional forces, and typically contain gouge along fracture planes which generally form impermeable barriers to groundwater flow.

6.0 CONCLUSIONS

Stream flow conditions in the north and south forks of Horse and Crandall Canyons, Blind Canyon, Indian Creek, and two drainages on the west-facing slope of East Mountain in T15S-R6E-Sec 35 W1/2, have been observed and recorded during seep and spring surveys conducted from 1985 through 1992. The two drainages on the west-facing slope of East Mountain in T15S-R6E-Sec 35 W1/2, have been observed to be dry during all fall seep and spring surveys conducted from 1985 through 1990. Flow was observed in these two drainages during the fall 1991 survey; however, stream flow was not measured due to the presence of conditions (falling rain and melting snow) that mask natural perennial flow conditions.

Observations of stream flow conditions present during October 1989 indicate perennial flow existed below the following elevations: 8300 ft. AMSL (Blind Canyon), 8400 ft. AMSL (North Fork of Crandall Canyon), and 8440 ft. AMSL (South Fork of Crandall Canyon).

Stream flow measurements collected in 1991 indicate perennial flow existed below the following elevations: 9400 ft. AMSL (South Fork of Horse Canyon), 9640 ft. AMSL (Blind Canyon), 9020 ft. AMSL (North Fork of Crandall Canyon), 8940 ft. AMSL (South Fork of Crandall Canyon), and no perennial flow (North Fork of Horse Canyon).

Tritium dates of spring waters collected from both Joes Valley and the west-facing slope of East Mountain indicate mixing of old and new waters. Geochemical analysis of spring waters collected from both Joes Valley and the west-facing slope of East Mountain reveal that the general character of all the groundwater samples are that of a calcium-magnesium-bicarbonate water. As a result, when these results are interpreted in conjunction with the tritium results, these data neither confirm or negate the presence of one or more than one hydrologic system supplying water to the upper Indian Creek.

Aerial photographs taken in 1976 and 1984 reveal the presence of a substantial amount of natural mass movement on the west-facing slope of East Mountain. Field observations of curved tree trunks resulting from soil movement also indicate a large degree of natural down-slope soil movement. The presence of sediment lobes at the base of East Mountain further suggest the presence of historic natural mass movement down the west-facing slope of East Mountain.

Modeling of subsidence that would result from retreat mining under East Mountain indicate the maximum degree of lowering of East Mountain will be no more than three to four inches. The draw angle is expected to be on the order of 20°.

X-ray diffraction analysis of the Hiawatha Coal Seam overburden (Blackhawk, Castlegate, and Price River Formations) indicate the presence of a number of clay minerals (EarthFax, 1992). Swelling clays present include mixed-layer smectite-illite, mixed-layer smectite-chlorite, and pure smectite (bentonite). These swelling clay minerals are able to occlude void areas and impede migration of groundwater. Other clay minerals present that will aid in further sealing fractures that result from retreat mining include kaolin and illite. Precipitation of calcite along the fracture planes will also aid in sealing fractures that result from retreat mining.

A Fish Lake National Forest study indicates that 56 percent of the tension fractures produced by retreat mining are physically self-healing (DeGraff, 1978). Average fracture closure rates of greater than 1/16 inch per week were measured (DeGraff, 1978). These data indicate that 56 percent of the maximum width of tension fractures are physically self-healing. Due to the presence of (1) clay minerals (principally swelling clays), and (2) precipitation of calcite cement in the overburden of the Hiawatha Coal at the Crandall Canyon Mine, and (3) physical closure of tension fractures, the likelihood of fracture development adversely affecting the hydrologic system (principally small discontinuous perched aquifers) of East Mountain is considered very minimal. Furthermore, the anticipated magnitudes of subsidence (maximum of no more than 3 to 4 inches) of East Mountain further shed considerable doubt on the possibility that adverse effects from retreat mining may occur.

7.0 REFERENCES

DeGraff, J.V., 1978, Geologic Investigation of Subsidence Tension Crack "Self-Healing" Phenomena, Environmental Geology, U.S. Department of Agriculture, Fish Lake National Forest, 9 pp.

EarthFax Engineering Inc., 1992, Mineralogy of the Crandall Canyon Mine Overburden, Implications For Healing of Fractures Resulting From Retreat Mining, Salt Lake City, Utah, 100 pp.

TerraTek, 1991, Preliminary Study of Potential Subsidence Over the Genwal Coal Mine, Salt Lake City, Utah, 7 pp.

APPENDIX 1

TRITIUM LABORATORY ANALYTICAL RESULTS

July 10, 1992

TRITIUM LABORATORY

Data Release #92-45
Job # 409

EARTHFAX ENGINEERING, INC.
TRITIUM SAMPLES

H. Gote Ostlund
Head, Tritium Laboratory

Distribution:
Earthfax Engineering, Inc.
7324 South 1300 East Ste. 100
Midvale, UT 84047
Attention: Brent Bovee

Rosenstiel School of Marine and Atmospheric Science
Tritium Laboratory
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Revised February 12, 1992

GENERAL COMMENTS ON TRITIUM RESULTS

Tritium Scales

The tritium concentrations are expressed in TU, where 1 TU indicates a T/H ratio of 10^{-18}. The values refer to the old, internationally-adopted scale of U.S. National Bureau of Standards (NBS), which is based on their tritium water standard #4926 as measured on 1961/09/03, and age-corrected with the old half-life of 12.26 years, i.e., $\lambda = 5.65\%$ $year^{-1}$. In this scale, 1 TU is 7.186 dpm/kg H_2O, or 3.237 pCi/kg H_2O. TU values are calculated for date of sample collection, REFDATE in the table, as provided by the submitter. If no such date is available, date of arrival of sample at our laboratory is used. The stated errors, eTU are one standard deviation (1 sigma) including all conceivable contributions.

In the table, QUANT is quantity of sample received, and ELYS is the amount of water taken for electrolytic enrichment. DIR means direct run (no enrichment).

It has been found lately that a better value for the half-life is 12.43 years, i.e., $\lambda = 5.576\%$ $year^{-1}$. This will cause a change in the TU scale, which is still based on the same NBS standard (#4926) as of the same date, 1961/09/03 (Ref below) In the new scale, 1 TU(new) is 7.088 dpm/kg H_2O, 3.193 pCi/kg H_2O. To convert from the current, old, scale to the new scale at any given point in time, multiply the listed TU(old)-values by f, where

$$f = 1.0368 + (year-1990) \times 0.0008$$

i.e. for 1992 the factor is 1.0384. The formula is correct within 0.02% between 1962 and 1999.

Very low tritium values

In some cases, negative TU values are listed. Such numbers can occur because the net tritium count rate is, in principle the difference between the count rate of the sample and that of a tritium-free sample (background count or blank sample). Given a set of "unknown" samples with no tritium, the distribution of net results should become symmetrical around 0 TU. The negative values are reported as such for the benefit of allowing the user unbiased statistical treatment of sets of the data. For other applications, 0 TU should be used.

References:

Mann, W.B., M.P. Unterweger, and B.M. Coursey, Comments on the NBS tritiated-water standards and their use, *Int. J. Appl. Radiat. Isot.*, 33, 383-386, 1982.

Taylor, C.B., and W. Roether, A uniform scale for reporting low-level tritium measurements in water, *Int. J. Appl. Radiat. Isot.*, *33*, 377-382, 1982.

Client: EARTHFAX ENGINEERING
Recvd : 92/06/17
Job# : 409
Final : 92/07/08

Purchase Order: CHECK
Contact: Brent Bovee 801/561-1555
7324 SOUTH 1300 EAST STE 100
MIDVALE UT 84047

Cust LABEL INFO	JOB.SX	REFDATE	QUANT	ELYS	TU	eTU
EARTHFAX- 1	409.01	920611	1000	161	29.2	1.0
EARTHFAX- 2	409.02	920611	1000	157	38.2	1.3
EARTHFAX- 3	409.03	920611	1000	275	33.3	1.1
EARTHFAX- 4	409.04	920611	1000	273	19.2	0.6

APPENDIX 2

GEOCHEMICAL LABORATORY ANALYTICAL RESULTS

CHEMTECH
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6100 S. STRATLER
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DATE: 7-10-92

TO: EarthFax Engineering
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Midvale, Utah 84047

SAMPLE ID: Lab #U078686 - Genwal, #1, 6-11-92
DATE SUBMITTED: 6-12-92

CERTIFICATE OF ANALYSIS

PARAMETER	DETECTED	DATE ANALYZED
TDS, mg/l	289	6-15-92
Hardness as $CaCO_3$, mg/l	276	6-17-92
Bicarbonate as HCO_3, mg/l	328	6-24-92
Carbonate as CO_3, mg/l	0	6-24-92
Chloride as Cl, mg/l	2.3	6-17-92
Fluoride as F, mg/l	<.1	6-18-92
Ammonia as NH_3-N, mg/l	<.2	6-15-92
Nitrate as NO_3-N, mg/l	0.245	6-12-92
Nitrite as NO_2-N, mg/l	<.005	6-15-92
Phosphorus as P, mg/l	0.014	6-27-92
Sulfate as SO_4, mg/l	16	6-25-92
Sulfide as S, mg/l	<.5	6-16-92
Aluminum as Al (T), mg/l	0.19	7-07-92
Arsenic as As (T), mg/l	<.05	7-07-92
Barium as Ba (T), mg/l	0.216	7-07-92
Boron as B (T), mg/l	<.1	7-09-92
Cadmium as Cd (T), mg/l	<.01	7-07-92
Calcium as Ca (T), mg/l	92.3	7-02-92
Chromium as Cr (T), mg/l	<.01	7-07-92

NOTE: Received nitrite samples past holding time.

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CHEMTECH
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Midvale, Utah 84047

SAMPLE ID: Lab #U078686 - Genwal, #1, 6-11-92
DATE SUBMITTED: 6-12-92

CERTIFICATE OF ANALYSIS

PARAMETER	DETECTED	DATE ANALYZED
Copper as Cu (T), mg/l	<.01	7-07-92
Lead as Pb (T), mg/l	<.01	7-07-92
Magnesium as Mg (T), mg/l	18.0	7-02-92
Manganese as Mn (T), mg/l	0.012	7-07-92
Mercury as Hg (T), mg/l	<.0005	6-23-92
Molybdenum as Mo (T), mg/l	<.01	7-07-92
Nickel as Ni (T), mg/l	<.01	7-07-92
Potassium as K (T), mg/l	0.6	7-02-92
Selenium as Se (T), mg/l	0.005	7-07-92
Sodium as Na (T), mg/l	1.8	7-01-92
Zinc as Zn (T), mg/l	0.225	7-07-92
Iron as Fe (Diss), mg/l	0.230	7-07-92
Cation, meq/l	6.16	
Anion, meq/l	5.77	

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CHEMTECH

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Midvale, Utah 84047

SAMPLE ID: Lab #U078687 - Genwal, #2, 6-11-92
DATE SUBMITTED: 6-12-92

CERTIFICATE OF ANALYSIS

PARAMETER	DETECTED	DATE ANALYZED
TDS, mg/l	262	6-15-92
Hardness as $CaCO_3$, mg/l	276	6-17-92
Bicarbonate as HCO_3, mg/l	332	6-24-92
Carbonate as CO_3, mg/l	0	6-24-92
Chloride as Cl, mg/l	3.5	6-17-92
Fluoride as F, mg/l	<.1	6-18-92
Ammonia as NH_3-N, mg/l	<.2	6-15-92
Nitrate as NO_3-N, mg/l	0.967	6-12-92
Nitrite as NO_2-N, mg/l	<.005	6-15-92
Phosphorus as P, mg/l	0.114	6-27-92
Sulfate as SO_4, mg/l	9.5	6-25-92
Sulfide as S, mg/l	<.5	6-16-92
Aluminum as Al (T), mg/l	1.19	7-07-92
Arsenic as As (T), mg/l	<.05	7-07-92
Barium as Ba (T), mg/l	0.265	7-07-92
Boron as B (T), mg/l	<.1	7-09-92
Cadmium as Cd (T), mg/l	<.01	7-07-92
Calcium as Ca (T), mg/l	91.9	7-02-92
Chromium as Cr (T), mg/l	<.01	7-07-92

NOTE: Received nitrite samples past holding time.

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Midvale, Utah 84047

SAMPLE ID: Lab #U078687 - Genwal, #2, 6-11-92
DATE SUBMITTED: 6-12-92

CERTIFICATE OF ANALYSIS

PARAMETER	DETECTED	DATE ANALYZED
Copper as Cu (T), mg/l	<.01	7-07-92
Lead as Pb (T), mg/l	<.01	7-07-92
Magnesium as Mg (T), mg/l	21.2	7-02-92
Manganese as Mn (T), mg/l	0.027	7-07-92
Mercury as Hg (T), mg/l	<.0005	6-23-92
Molybdenum as Mo (T), mg/l	<.01	7-07-92
Nickel as Ni (T), mg/l	<.01	7-07-92
Potassium as K (T), mg/l	1.0	7-02-92
Selenium as Se (T), mg/l	<.005	7-07-92
Sodium as Na (T), mg/l	2.3	7-01-92
Zinc as Zn (T), mg/l	0.281	7-07-92
Iron as Fe (Diss), mg/l	0.50	7-07-92
Cation, meq/l	6.58	
Anion, meq/l	5.74	

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SAMPLE ID: Lab #U078688 - Genwal, #3, 6-11-92
DATE SUBMITTED: 6-12-92

CERTIFICATE OF ANALYSIS

PARAMETER	DETECTED	DATE ANALYZED
TDS, mg/l	302	6-15-92
Hardness as $CaCO_3$, mg/l	294	6-17-92
Bicarbonate as HCO_3, mg/l	338	6-24-92
Carbonate as CO_3, mg/l	0	6-24-92
Chloride as Cl, mg/l	4.4	6-17-92
Fluoride as F, mg/l	<.1	6-18-92
Ammonia as NH_3-N, mg/l	<.2	6-15-92
Nitrate as NO_3-N, mg/l	0.930	6-12-92
Nitrite as NO_2-N, mg/l	<.005	6-15-92
Phosphorus as P, mg/l	0.015	6-27-92
Sulfate as SO_4, mg/l	24	6-25-92
Sulfide as S, mg/l	<.5	6-16-92
Aluminum as Al (T), mg/l	0.37	7-07-92
Arsenic as As (T), mg/l	<.05	7-07-92
Barium as Ba (T), mg/l	0.201	7-07-92
Boron as B (T), mg/l	<.1	7-09-92
Cadmium as Cd (T), mg/l	<.01	7-07-92
Calcium as Ca (T), mg/l	90.9	7-02-92
Chromium as Cr (T), mg/l	<.01	7-07-92

NOTE: Received nitrite samples past holding time.

Rex Henderson

CHEMTECH

ANALYTICAL LABORATORY

6100 S. STRATLER
MURRAY, UTAH 84107
PHONE: (801) 262-7299
FAX: (801) 262-7378

DATE: 7-10-92

TO: EarthFax Engineering
7324 So. 1300 East
Midvale, Utah 84047

SAMPLE ID: Lab #U078688 - Genwal, #3, 6-11-92
DATE SUBMITTED: 6-12-92

CERTIFICATE OF ANALYSIS

PARAMETER	DETECTED	DATE ANALYZED
Copper as Cu (T), mg/l	<.01	7-07-92
Lead as Pb (T), mg/l	<.01	7-07-92
Magnesium as Mg (T), mg/l	23.0	7-02-92
Manganese as Mn (T), mg/l	<.01	7-07-92
Mercury as Hg (T), mg/l	<.0005	6-23-92
Molybdenum as Mo (T), mg/l	<.01	7-07-92
Nickel as Ni (T), mg/l	<.01	7-07-92
Potassium as K (T), mg/l	1.0	7-02-92
Selenium as Se (T), mg/l	0.005	7-07-92
Sodium as Na (T), mg/l	3.2	7-01-92
Zinc as Zn (T), mg/l	0.077	7-07-92
Iron as Fe (Diss), mg/l	0.35	7-07-92
Cation, meq/l	6.59	
Anion, meq/l	6.16	

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DATE: 7-10-92

TO: EarthFax Engineering
7324 So. 1300 East
Midvale, Utah 84047

SAMPLE ID: Lab #U078689 - Genwal, #4, 6-11-92
DATE SUBMITTED: 6-12-92

CERTIFICATE OF ANALYSIS

PARAMETER	DETECTED	DATE ANALYZED
TDS, mg/l	295	6-15-92
Hardness as $CaCO_3$, mg/l	296	6-17-92
Bicarbonate as HCO_3, mg/l	367	6-24-92
Carbonate as CO_3, mg/l	0	6-24-92
Chloride as Cl, mg/l	1.8	6-17-92
Fluoride as F, mg/l	0.107	6-18-92
Ammonia as NH_3-N, mg/l	<.2	6-15-92
Nitrate as NO_3-N, mg/l	0.365	6-12-92
Nitrite as NO_2-N, mg/l	<.005	6-15-92
Phosphorus as P, mg/l	0.017	6-27-92
Sulfate as SO_4, mg/l	1.4	6-25-92
Sulfide as S, mg/l	<.5	6-16-92
Aluminum as Al (T), mg/l	0.54	7-07-92
Arsenic as As (T), mg/l	<.05	7-07-92
Barium as Ba (T), mg/l	0.110	7-07-92
Boron as B (T), mg/l	<.1	7-09-92
Cadmium as Cd (T), mg/l	<.01	7-07-92
Calcium as Ca (T), mg/l	84.8	7-02-92
Chromium as Cr (T), mg/l	0.023	7-07-92

NOTE: Received nitrite samples past holding time.

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Midvale, Utah 84047

SAMPLE ID: Lab #U078689 - Genwal, #4, 6-11-92
DATE SUBMITTED: 6-12-92

CERTIFICATE OF ANALYSIS

PARAMETER	DETECTED	DATE ANALYZED
Copper as Cu (T), mg/l	<.01	7-07-92
Lead as Pb (T), mg/l	<.01	7-07-92
Magnesium as Mg (T), mg/l	24.3	7-02-92
Manganese as Mn (T), mg/l	<.01	7-07-92
Mercury as Hg (T), mg/l	<.0005	6-23-92
Molybdenum as Mo (T), mg/l	<.01	7-07-92
Nickel as Ni (T), mg/l	<.01	7-07-92
Potassium as K (T), mg/l	0.4	7-02-92
Selenium as Se (T), mg/l	<.005	7-07-92
Sodium as Na (T), mg/l	1.6	7-01-92
Zinc as Zn (T), mg/l	0.019	7-07-92
Iron as Fe (Diss), mg/l	0.38	7-07-92
Cation, meq/l	6.30	
Anion, meq/l	6.09	

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DATE: 7-10-92

TO: EarthFax Engineering
7324 So. 1300 East
Midvale, Utah 84047

SAMPLE ID: Lab #U078690 - Genwal, 1-53 Stream, 6-11-92
DATE SUBMITTED: 6-12-92

CERTIFICATE OF ANALYSIS

PARAMETER	DETECTED	DATE ANALYZED
TDS, mg/l	235	6-15-92
Hardness as $CaCO_3$, mg/l	229	6-17-92
Bicarbonate as HCO_3, mg/l	266	6-24-92
Carbonate as CO_3, mg/l	0	6-24-92
Chloride as Cl, mg/l	2.6	6-17-92
Fluoride as F, mg/l	0.105	6-18-92
Ammonia as NH_3-N, mg/l	<.2	6-15-92
Nitrate as NO_3-N, mg/l	0.154	6-12-92
Nitrite as NO_2-N, mg/l	<.005	6-15-92
Phosphorus as P, mg/l	0.012	6-27-92
Sulfate as SO_4, mg/l	24	6-25-92
Sulfide as S, mg/l	<.5	6-16-92
Aluminum as Al (T), mg/l	0.28	7-07-92
Arsenic as As (T), mg/l	<.05	7-07-92
Barium as Ba (T), mg/l	0.075	7-07-92
Boron as B (T), mg/l	<.1	7-09-92
Cadmium as Cd (T), mg/l	<.01	7-07-92
Calcium as Ca (T), mg/l	59.8	7-02-92
Chromium as Cr (T), mg/l	<.01	7-07-92

NOTE: Received nitrite samples past holding time.

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7324 So. 1300 East
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SAMPLE ID: Lab #U078690 - Genwal, 1-53 Stream, 6-11-92
DATE SUBMITTED: 6-12-92

CERTIFICATE OF ANALYSIS

PARAMETER	DETECTED	DATE ANALYZED
Copper as Cu (T), mg/l	<.01	7-07-92
Lead as Pb (T), mg/l	0.016	7-07-92
Magnesium as Mg (T), mg/l	20.9	7-02-92
Manganese as Mn (T), mg/l	<.01	7-07-92
Mercury as Hg (T), mg/l	<.0005	6-23-92
Molybdenum as Mo (T), mg/l	<.01	7-07-92
Nickel as Ni (T), mg/l	<.01	7-07-92
Potassium as K (T), mg/l	1.1	7-02-92
Selenium as Se (T), mg/l	<.005	7-07-92
Sodium as Na (T), mg/l	4.4	7-01-92
Zinc as Zn (T), mg/l	0.040	7-07-92
Iron as Fe (Diss), mg/l	0.50	7-07-92
Cation, meq/l	4.92	
Anion, meq/l	4.93	

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DATE: 7-10-92

TO: EarthFax Engineering
7324 So. 1300 East
Midvale, Utah 84047

SAMPLE ID: Lab #U078691 - Genwal, 1-30a, 6-11-92
DATE SUBMITTED: 6-12-92

CERTIFICATE OF ANALYSIS

PARAMETER	DETECTED	DATE ANALYZED
TDS, mg/l	209	6-15-92
Hardness as $CaCO_3$, mg/l	257	6-17-92
Bicarbonate as HCO_3, mg/l	296	6-24-92
Carbonate as CO_3, mg/l	0	6-24-92
Chloride as Cl, mg/l	2.8	6-17-92
Fluoride as F, mg/l	<.1	6-18-92
Ammonia as NH_3-N, mg/l	0.24	6-15-92
Nitrate as NO_3-N, mg/l	0.463	6-12-92
Nitrite as NO_2-N, mg/l	<.005	6-15-92
Phosphorus as P, mg/l	0.044	6-27-92
Sulfate as SO_4, mg/l	24	6-25-92
Sulfide as S, mg/l	<.5	6-16-92
Aluminum as Al (T), mg/l	0.88	7-07-92
Arsenic as As (T), mg/l	<.05	7-07-92
Barium as Ba (T), mg/l	0.069	7-07-92
Boron as B (T), mg/l	<.1	7-09-92
Cadmium as Cd (T), mg/l	<.01	7-07-92
Calcium as Ca (T), mg/l	63.7	7-02-92
Chromium as Cr (T), mg/l	<.01	7-07-92

NOTE: Received nitrite samples past holding time.

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DATE: 7-10-92

TO: EarthFax Engineering
7324 So. 1300 East
Midvale, Utah 84047

SAMPLE ID: Lab #U078691 - Genwal, 1-30a, 6-11-92
DATE SUBMITTED: 6-12-92

CERTIFICATE OF ANALYSIS

PARAMETER	DETECTED	DATE ANALYZED
Copper as Cu (T), mg/l	<.01	7-07-92
Lead as Pb (T), mg/l	<.01	7-07-92
Magnesium as Mg (T), mg/l	23.5	7-02-92
Manganese as Mn (T), mg/l	0.019	7-07-92
Mercury as Hg (T), mg/l	<.0005	6-23-92
Molybdenum as Mo (T), mg/l	<.01	7-07-92
Nickel as Ni (T), mg/l	<.01	7-07-92
Potassium as K (T), mg/l	1.1	7-02-92
Selenium as Se (T), mg/l	<.005	7-07-92
Sodium as Na (T), mg/l	3.9	7-01-92
Zinc as Zn (T), mg/l	0.207	7-07-92
Iron as Fe (Diss), mg/l	0.37	7-07-92
Cation, meq/l	5.31	
Anion, meq/l	5.43	

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DATE: 7-10-92

TO: EarthFax Engineering
7324 So. 1300 East
Midvale, Utah 84047

SAMPLE ID: Lab #U078692 - Genwal, 1-31, 6-11-92
DATE SUBMITTED: 6-12-92

CERTIFICATE OF ANALYSIS

PARAMETER	DETECTED	DATE ANALYZED
TDS, mg/l	270	6-15-92
Hardness as $CaCO_3$, mg/l	248	6-17-92
Bicarbonate as HCO_3, mg/l	298	6-24-92
Carbonate as CO_3, mg/l	0	6-24-92
Chloride as Cl, mg/l	2.0	6-17-92
Fluoride as F, mg/l	0.103	6-18-92
Ammonia as NH_3-N, mg/l	0.24	6-15-92
Nitrate as NO_3-N, mg/l	0.260	6-12-92
Nitrite as NO_2-N, mg/l	<.005	6-15-92
Phosphorus as P, mg/l	<.01	6-27-92
Sulfate as SO_4, mg/l	22	6-25-92
Sulfide as S, mg/l	<.5	6-16-92
Aluminum as Al (T), mg/l	<.1	7-07-92
Arsenic as As (T), mg/l	<.05	7-07-92
Barium as Ba (T), mg/l	0.046	7-07-92
Boron as B (T), mg/l	<.1	7-09-92
Cadmium as Cd (T), mg/l	<.01	7-07-92
Calcium as Ca (T), mg/l	62.7	7-02-92
Chromium as Cr (T), mg/l	<.01	7-07-92

NOTE: Received nitrite samples past holding time.

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Midvale, Utah 84047

SAMPLE ID: Lab #U078692 - Genwal, 1-31, 6-11-92
DATE SUBMITTED: 6-12-92

CERTIFICATE OF ANALYSIS

PARAMETER	DETECTED	DATE ANALYZED
Copper as Cu (T), mg/l	<.01	7-07-92
Lead as Pb (T), mg/l	<.01	7-07-92
Magnesium as Mg (T), mg/l	21.1	7-02-92
Manganese as Mn (T), mg/l	<.01	7-07-92
Mercury as Hg (T), mg/l	<.0005	6-23-92
Molybdenum as Mo (T), mg/l	<.01	7-07-92
Nickel as Ni (T), mg/l	0.012	7-07-92
Potassium as K (T), mg/l	0.7	7-02-92
Selenium as Se (T), mg/l	<.005	7-07-92
Sodium as Na (T), mg/l	7.1	7-01-92
Zinc as Zn (T), mg/l	0.304	7-07-92
Iron as Fe (Diss), mg/l	0.39	7-07-92
Cation, meq/l	5.17	
Anion, meq/l	5.39	

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